



Fuel Cells and California's Energy Future

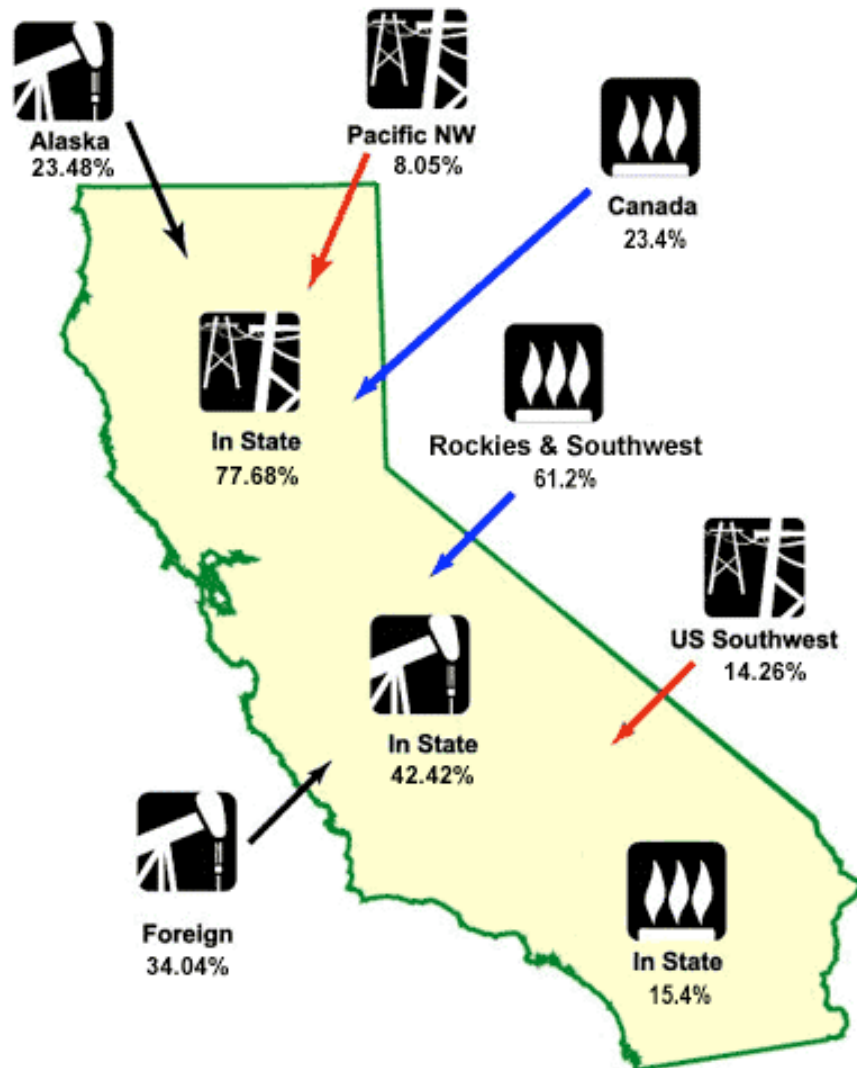
*Martha Krebs, Ph.D.
Deputy Director for R&D
California Energy Commission*

*PIER Workshop on Fuel Cells
Sacramento, California
May 31, 2006*

Outline

- California Energy Picture.
- California energy policy summary.
- How PIER fits in
- Where this Workshop fits

California's Energy Picture



CALIFORNIA'S ENERGY SOURCES

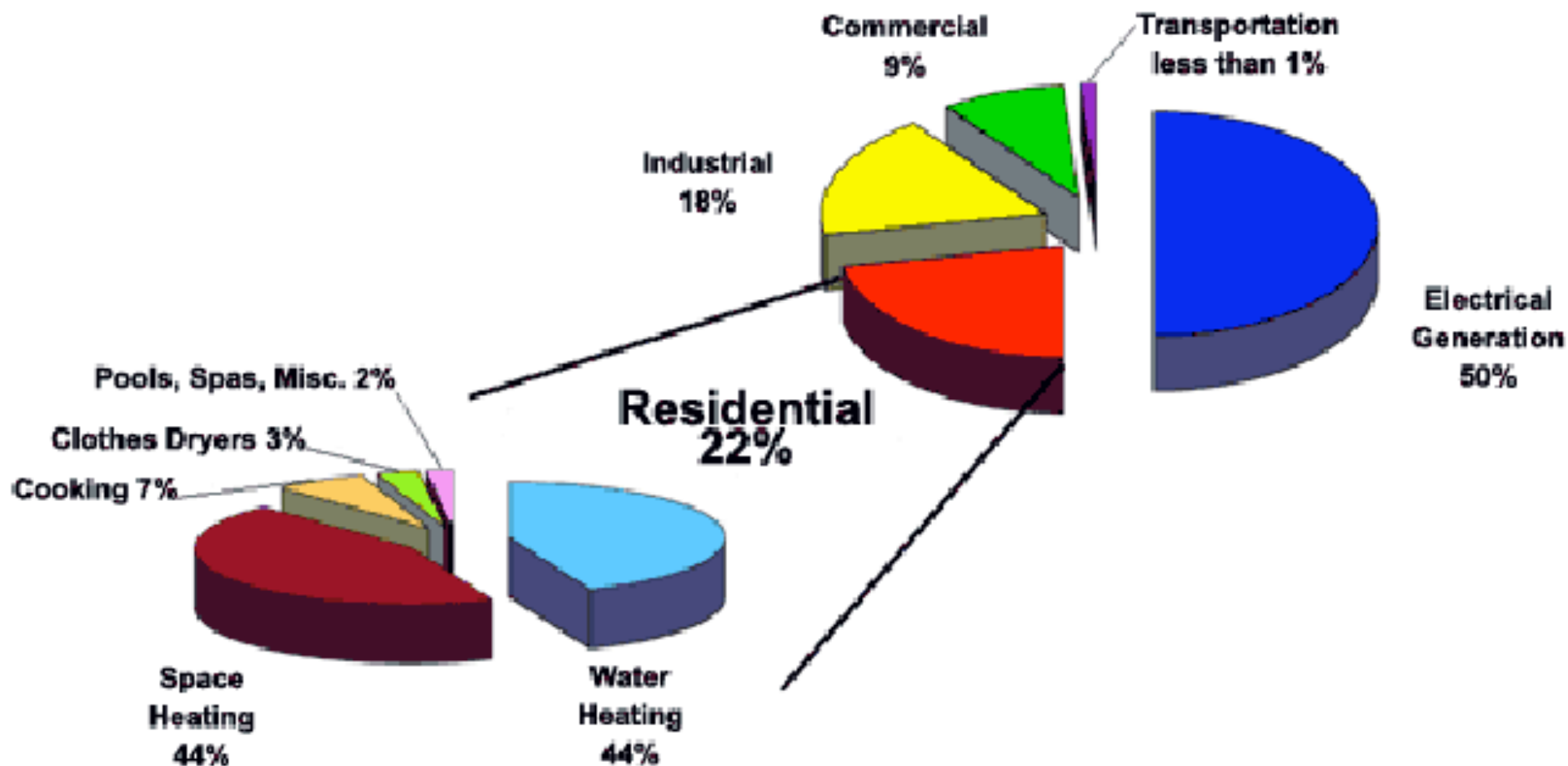
California produces
16% of its natural gas
42% of its petroleum
77% of its electricity

California ranks 3rd in crude oil production, 11th in natural gas production, 3rd in net hydroelectric power, 6th in nuclear power.

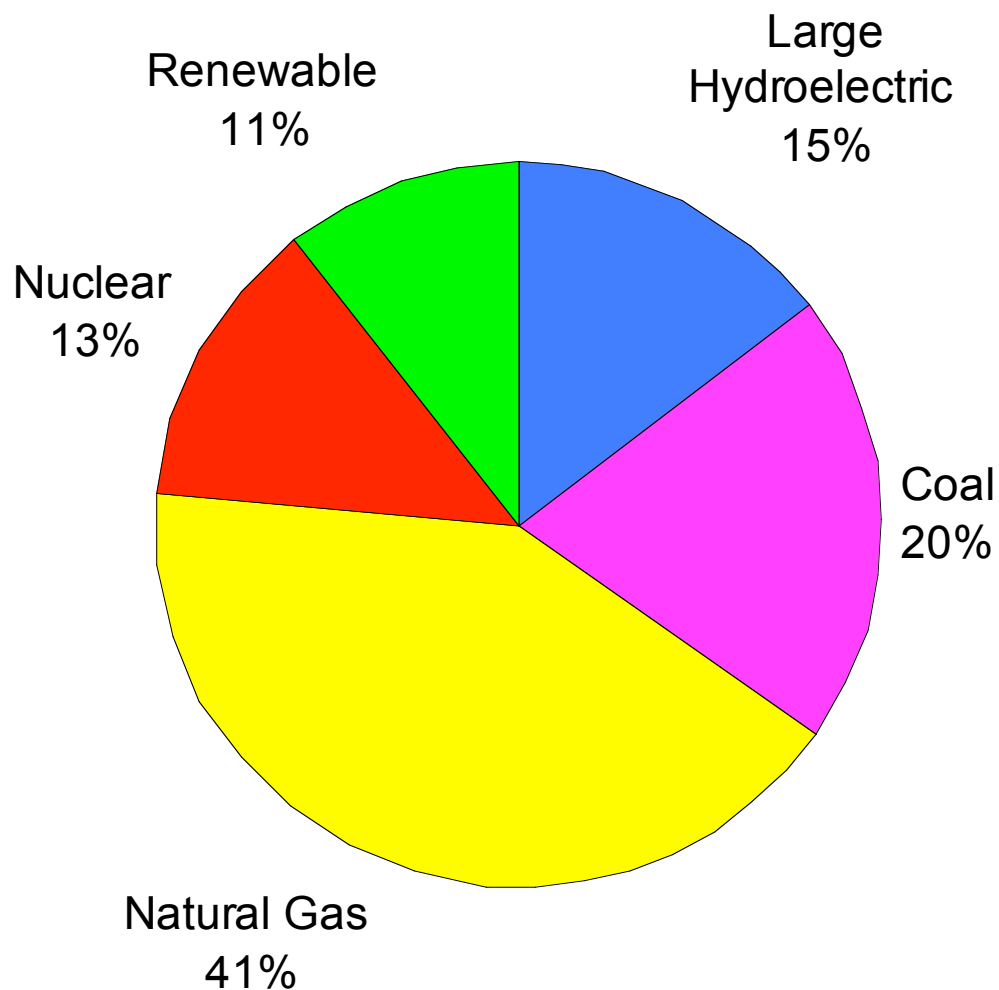
California ranks 2nd in total energy consumed, 1st in energy use in residential, commercial and transportation sectors and 3rd in the industrial sector.

California is 2nd in the use of natural gas, petroleum and electricity after Texas.

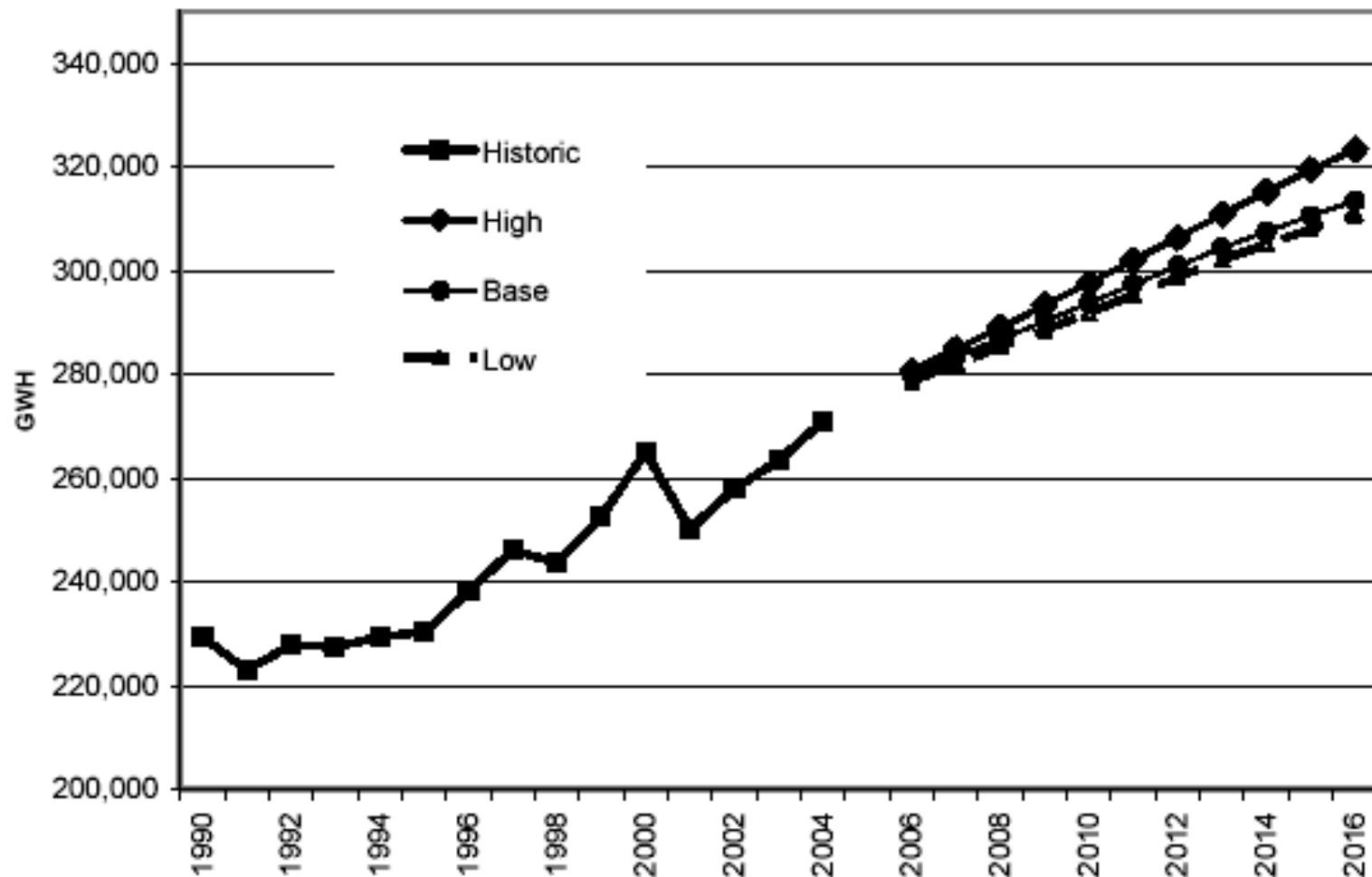
2004 Natural Gas Use in California



California Electricity Production 2004

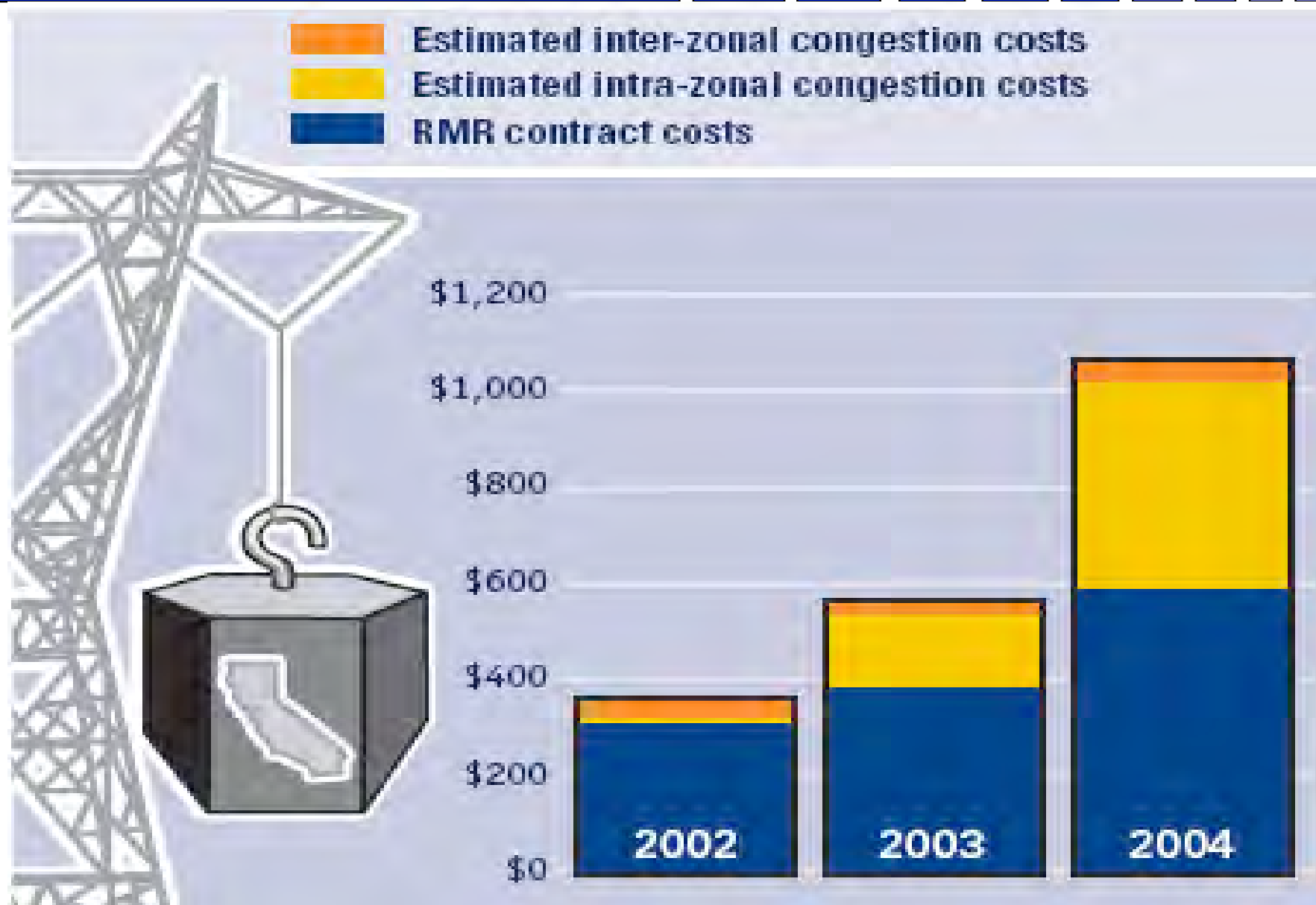


Statewide Electricity Consumption (1990 – 2016)



Source: California Energy Commission, *California Energy Demand 2006-2016, Staff Energy Forecast, Revised September 2005*, September 2005, CEC-400-2005-034-SF-ED2.

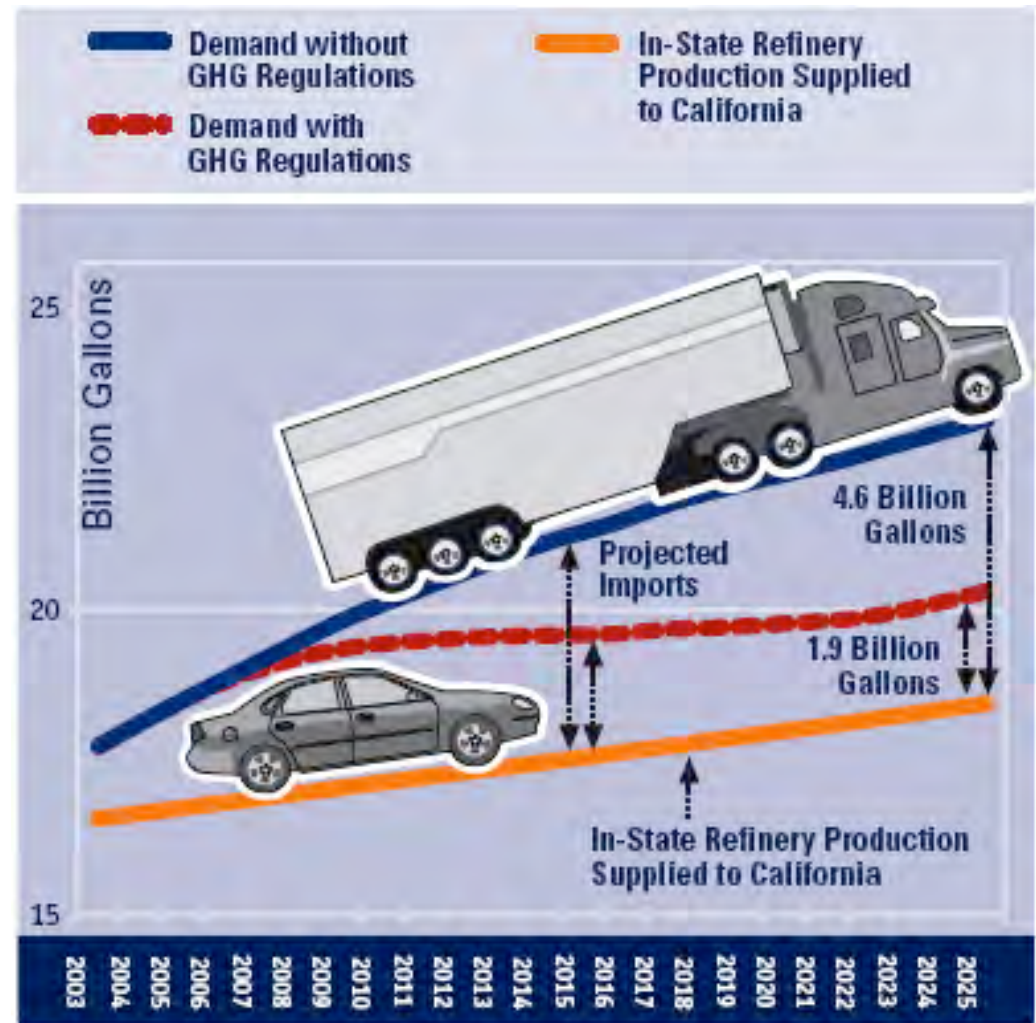
U.S. and California Congestion and Reliability Costs



Projected California Gasoline and Diesel Demand



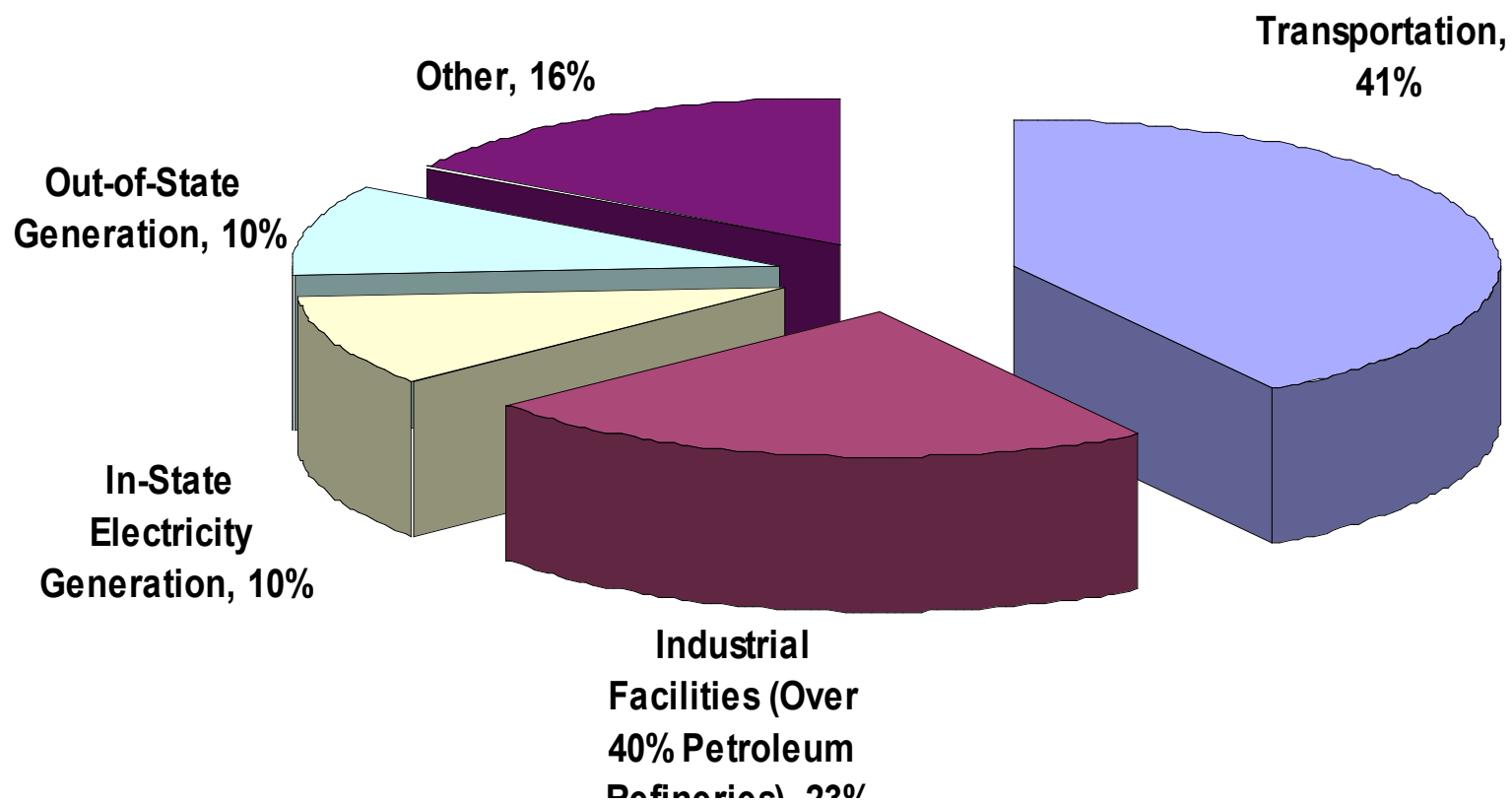
- Technology advances in petroleum use efficiencies have been driven by air emission standards
- California Air Resources Board
 - Regulates mobile sources (except ships, aircraft, trains)
 - Sets consumer products emission limits
 - Establishes air toxics risk reduction
- Bureau of Automotive Repair
 - Runs smog check
- Air quality management districts
 - Control stationary point sources
 - Control stationary area sources
- Most recent policy direction is AB1493 (Pavley Bill) which would require 30% reduction GHG emissions in new light duty vehicles by 2016



Source: California Energy Commission.



California Greenhouse Gas Emissions



The total GHG emissions for 2004 are ~500 million tons of CO₂ equivalent

California Energy Policy Framework



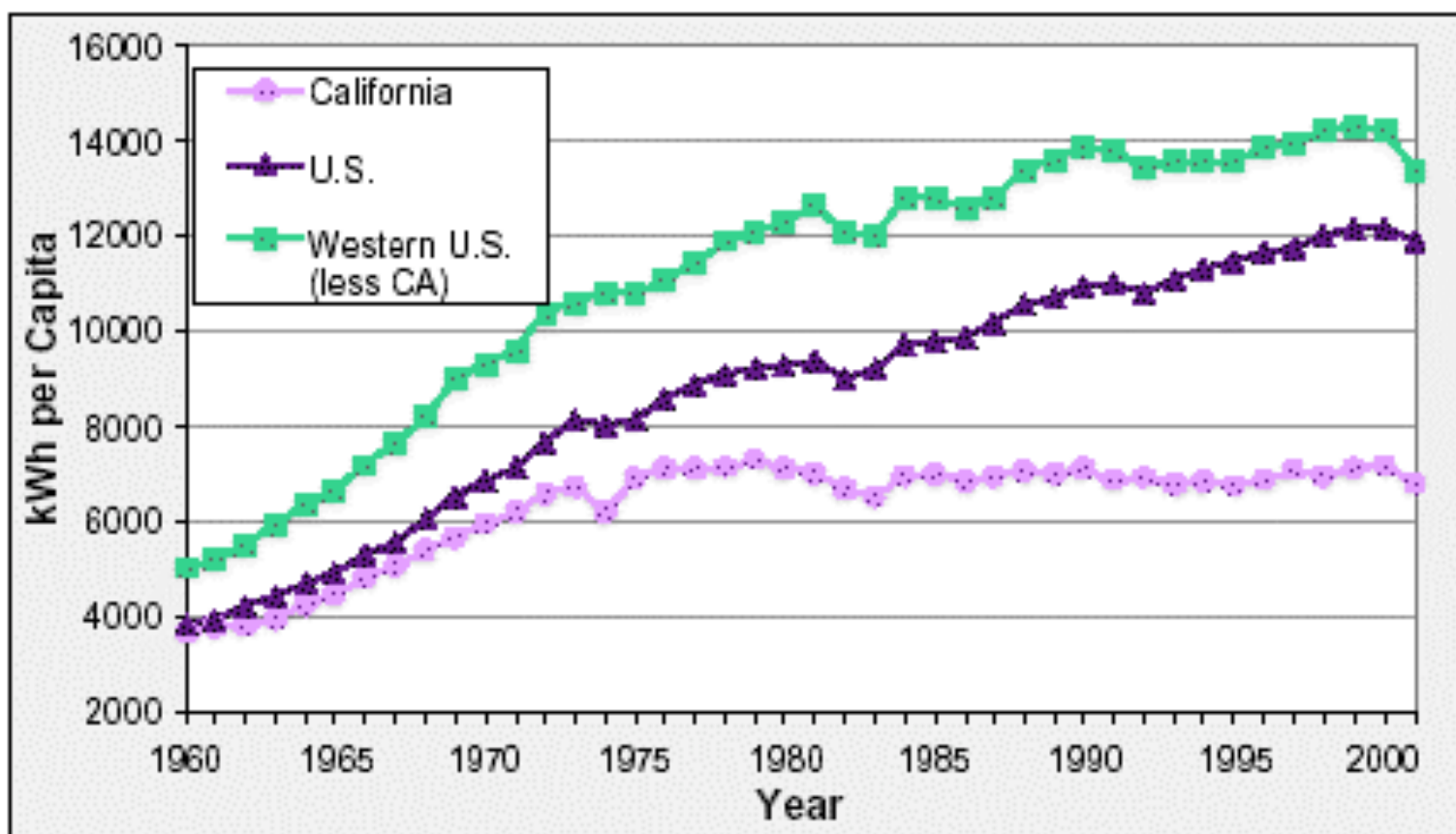
2005 Integrated Energy Policy Report

- Transportation Fuels
- Electricity Needs and Procurement Policies
- Demand-Side Resources, Distributed Generation and Other Electricity Supplies
- Transmission
- Renewable Resources for Electricity
- Natural Gas
- Integrated Water and Energy Strategies
- Global Climate Change
- Border Energy

Energy Action Plan II

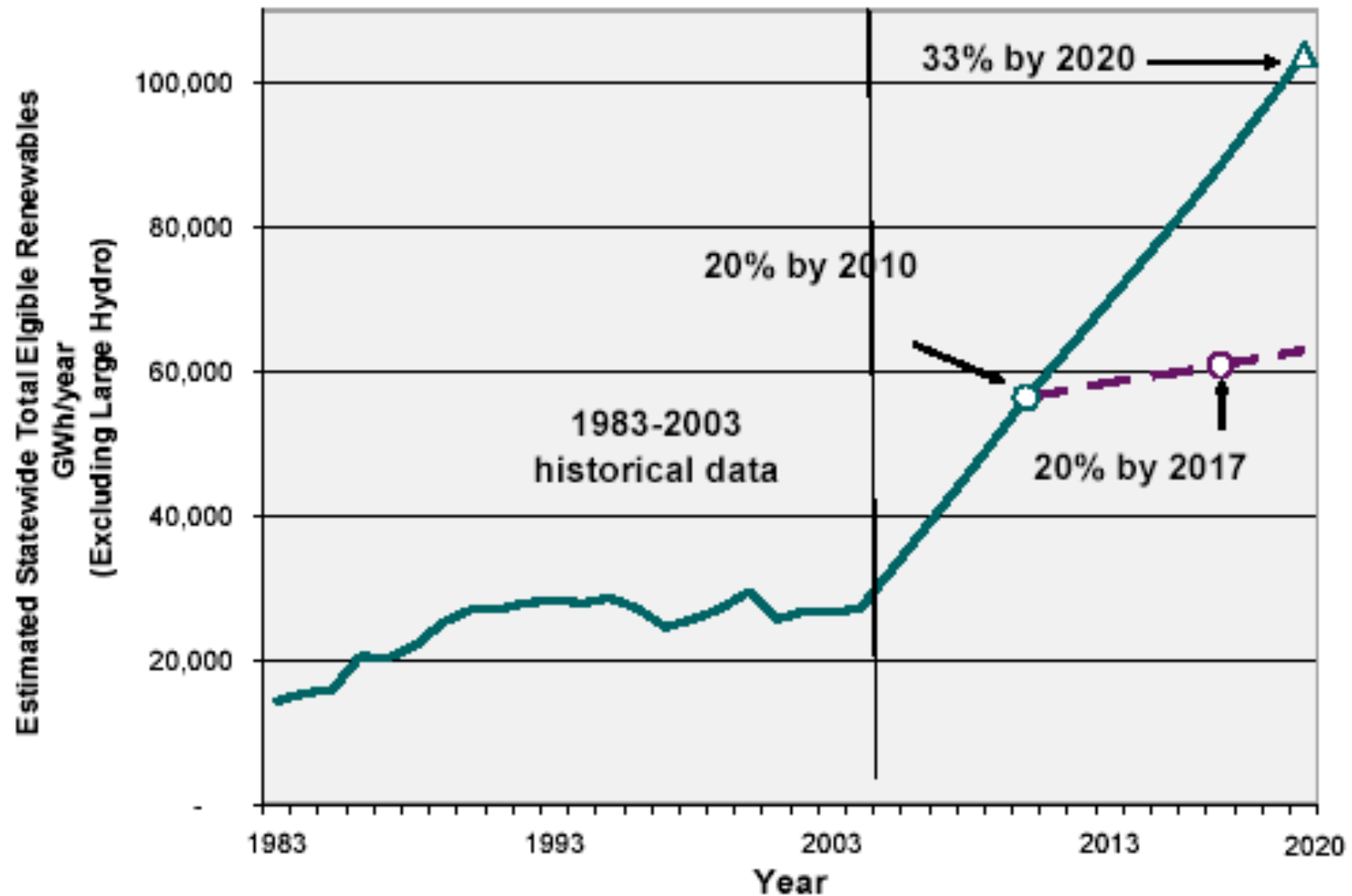
- Transportation Fuels Supply, Demand, and Infrastructure
- Electricity Adequacy, Reliability and Infrastructure
- Energy Efficiency
- Demand Response
- Electricity Market Structure
- Renewables
- Natural Gas Supply, Demand, and Infrastructure
- Climate Change
- Research, Development, and Demonstration

Total Electricity Use Per Capita 1960- 2001



Californians use almost 50 percent less electricity than the U.S. average
 Source: Energy Information Agency and California Energy Commission

California Renewable Energy Goals

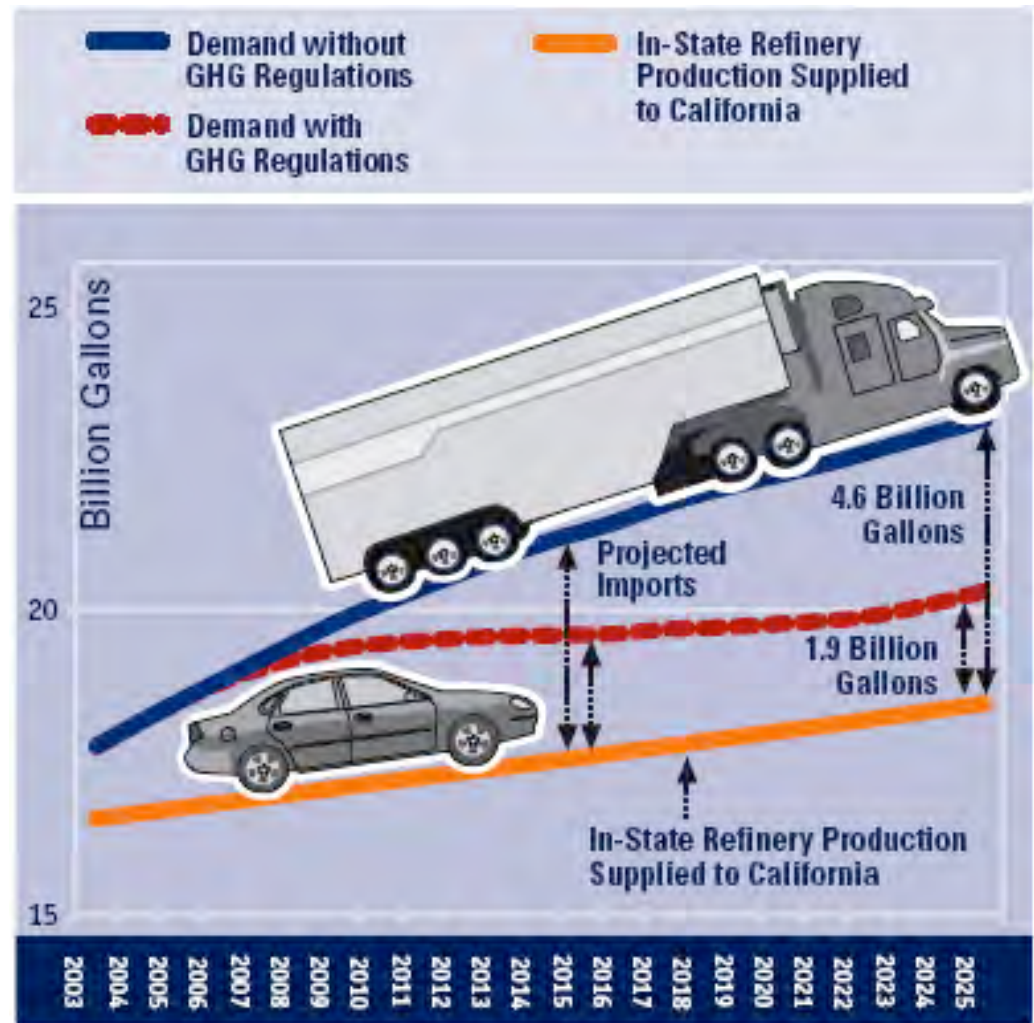


Source: California Energy Commission

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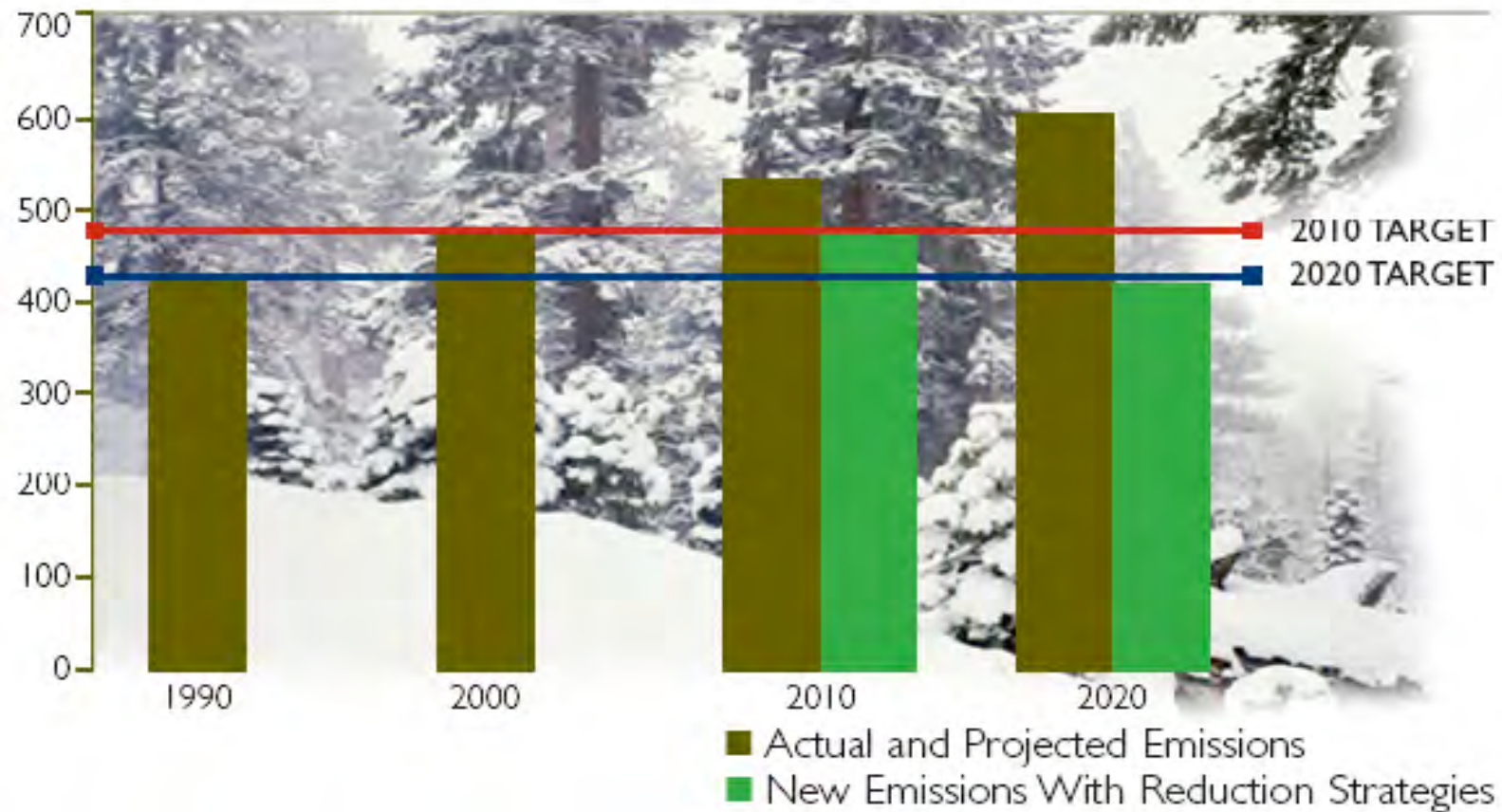


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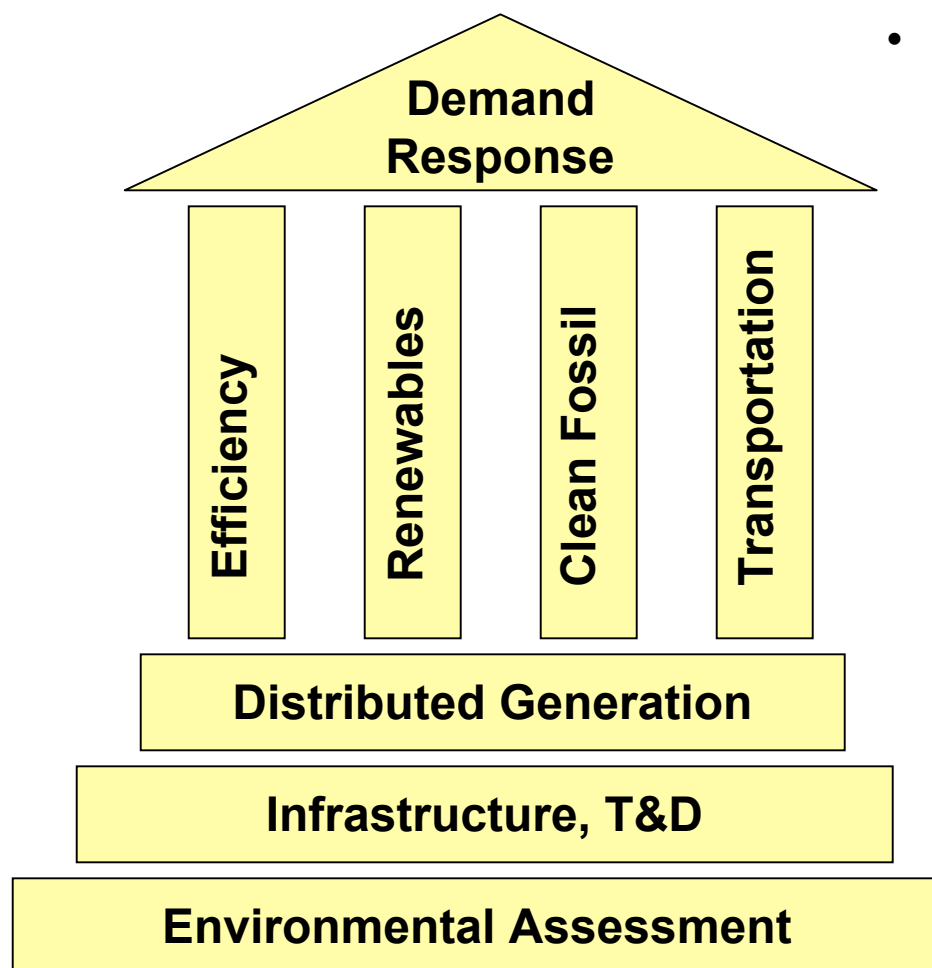


Source: California Energy Commission.

California Climate Change Emissions and Targets After Implementing Emission Reduction Strategies

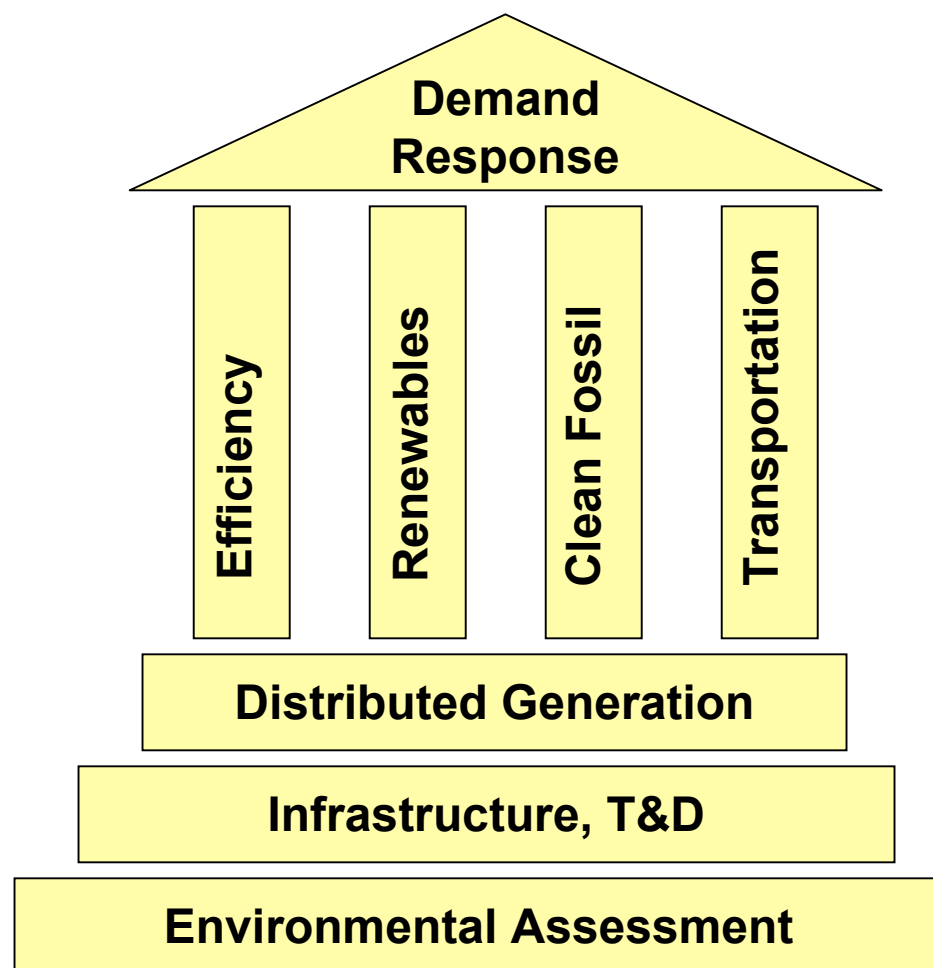


California's Public Interest Energy Research program is directed by law and CEC policy guidance



- **PIER was established in 1997 as part of Electricity Restructuring**
 - \$62.5 M annual funding for electricity research
 - Expanded in 2005 by CPUC rule to include natural gas research; will provide \$24M by 2009
 - Maintains capacity for applied energy research of benefit to electricity and natural gas ratepayers
 - Leverages public and private investments to advance energy-related S&T to inform California decisionmakers and provide Californians with clean, affordable energy services

Fuel Cell Technology Connects to Expectations for PIER



- **Clean, Efficient Electricity Generation**
 - Central Station
 - Balance for Variable Renewables
 - Distributed Resources
 - Located close to Loads
 - Mitigates Congestion
 - Combined Heat and Power
 - Sustainable Communities
- **Clean, Efficient Transportation**
 - Key concept for Hydrogen Highway
- **Reduces GHG in combination with Renewables or Carbon Sequestration**

Challenges to Fuel Cell Technology Deployment



- Technology Cost
- Durability
- Long Term Character of Development
 - SOFC going on 40 years
 - PEM about 20 years
- Multiple fuel cell technologies competing for scarce dollars
- Cost of near-term fuel source – Natural Gas
- Utility Resistance to Distributed Generation
- New Transportation Infrastructure creation
- For PIER – Effective leverage on the Federal Investment

Purpose of This Workshop

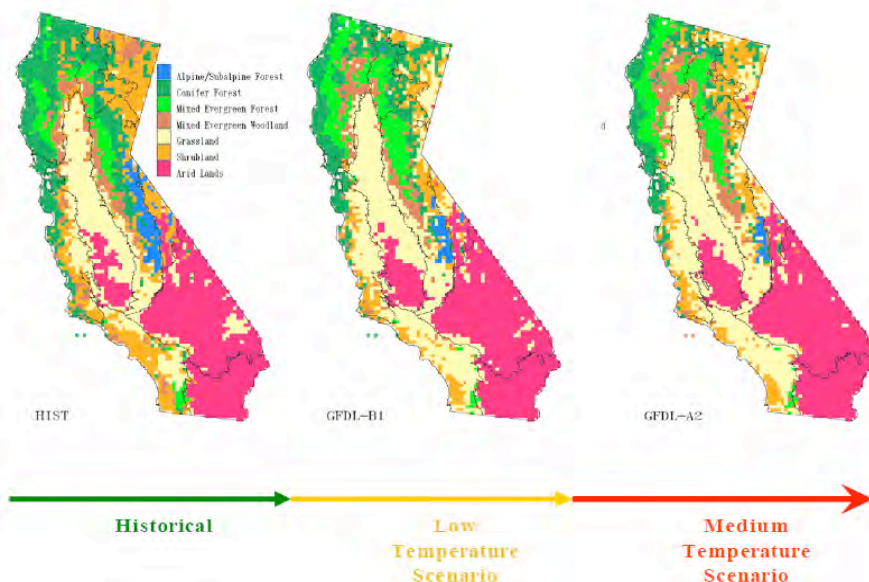


- Assist PIER in identifying critical opportunities for future investment in fuel cells
 - Technology issues – What are the key technology or systems questions that California needs to have answers for? How does PIER leverage private and public investment?
 - Ratepayer Benefits – How can PIER maximize the benefits from RD&D projects
- Critical Interdependencies
 - Policy issues – How does the new emphasis on Climate Change and GHG reduction open/shut doors for fuel cells in CA? Does it change the priorities in ‘the loading order’?
 - Market issues – What regulatory interventions will make a difference?

Thank You



Climate Change – Consequence evaluation of climate change and adaptation and mitigation strategies for California



Vegetation distribution under historical conditions and multiple climate change scenarios at end of century



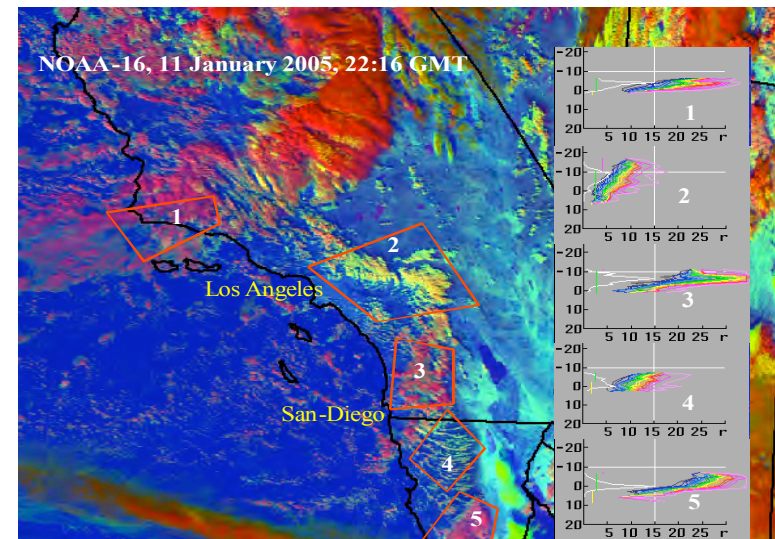
California Climate Change Center

- This center is the first state-sponsored climate change research program in the U.S.
- The goal is to produce policy relevant research products relative to impacts, mitigation and adaptation
- Understand climate change impacts in California and the northwestern United States
- Probabilistic Climate Scenarios
- Impacts to critical energy, water and ecological resources and infrastructure
- Supply curves for reducing/mitigating GHG emissions
- Improved dynamic economic modeling of adaptation and mitigation strategies appropriate for California
- Primary responsibility for '06 assessment of impacts and adaptation options for the Governor's Initiative
- \$20 Million initial investment in a five year program

Role of Aerosols on Precipitation in the Sierra Nevada

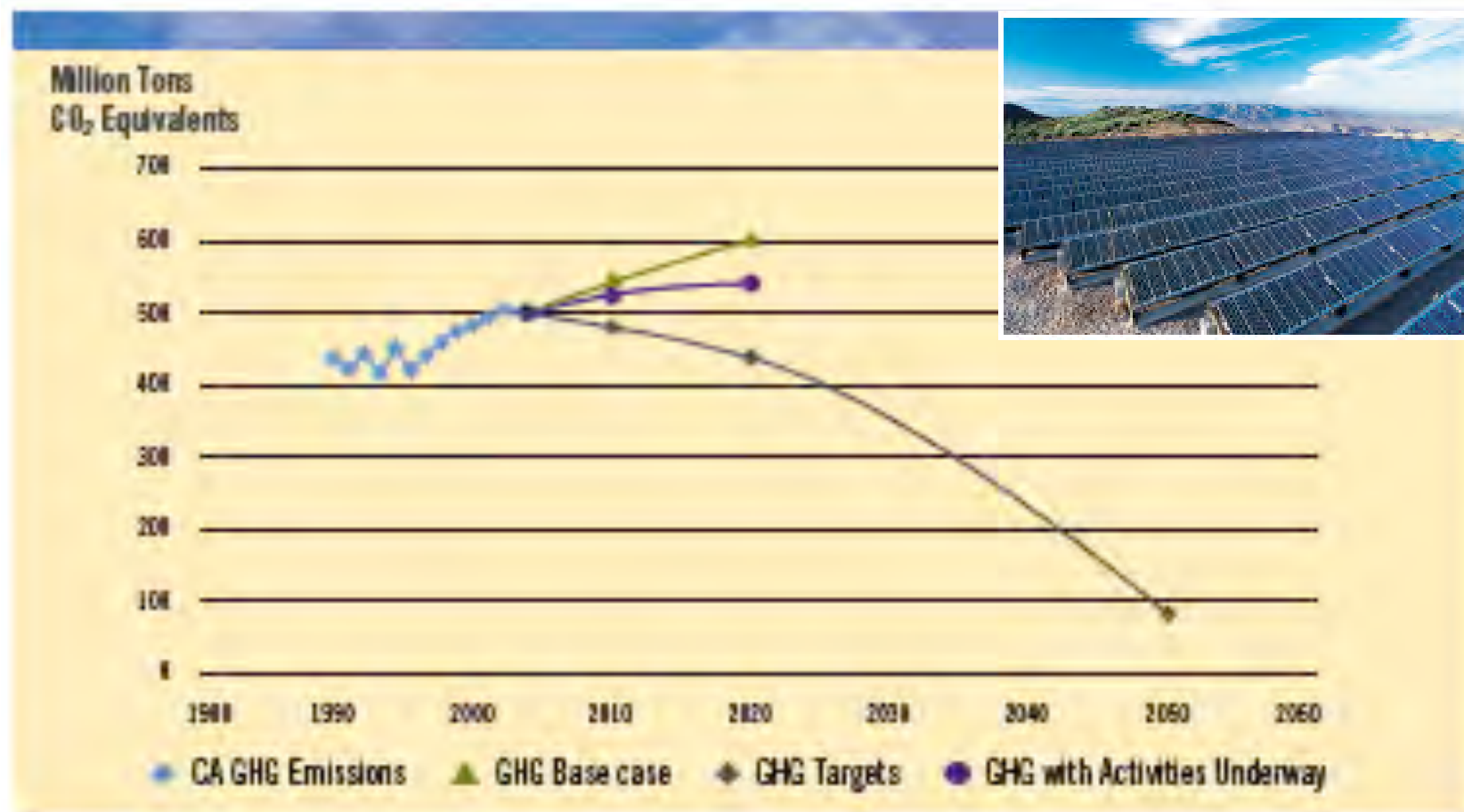


- Aerosols may be reducing precipitation levels in elevated areas (e.g., Sierra Nevada)
- CEC research has documented the phenomenon
- Ongoing research is designed to improve better understanding of this problem using:
 - Satellite analyses
 - Computer simulations
 - Field studies

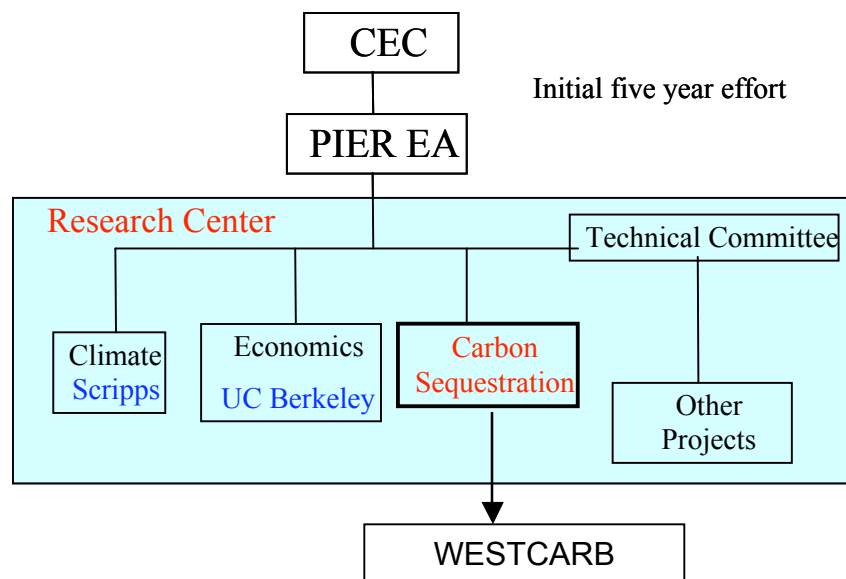


Source: Woodley and Rosenfeld, 2005

California greenhouse gas emission trends (CEC, 2005)



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- \$20 Million initial investment in a five year program
- Understand climate change impacts in California and the northwestern United States
- Examine alternative mitigation/adaptation options



California initiatives



“...the debate is over. We know the science. We see the threat. And we know the time for action is now.”—Gov. Schwarzenegger, 1 June 2005

Proposals include:

Mandatory greenhouse gas registry
Greenhouse gas cap and trade
Alternative transportation fuels

California's Public Interest Energy Research (PIER) Program



- PIER was established in 1997 as part of electricity restructuring
 - Maintains capacity for applied energy research of benefit to electricity ratepayers
 - \$62.5 M annual funding for research provided by surcharge on IOU ratepayers
 - Between 300-400 active projects
- PIER was expanded in 2005 by CPUC rule to include \$12 M of natural gas research
 - Expected to grow to \$24 M by 2009
- Leverages public and private investments to advance energy-related S&T to inform California decisionmakers and provide Californians with clean, affordable energy services

25 Trends and Drivers Affecting California's Energy Future

